VO2-driven switchable-beam directional antenna for micro/nano scale optical communications

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Abstract - In this study, we propose a switchable-beam directional antenna for micro/nano scale intrachip optical communications. Vanadium dioxide phase transition controls antenna's beam by affecting director's resonance frequency in a Yagi-Uda array and transforming them to reflector elements. A considerable gain manipulation is achievable by this method depending on array size.

Intrachip micro/nano scale communication fascinated researchers to develop optical antennas for wireless purposes due to a huge metallic absorption losses of plasmonic waveguides [1]. Yagi-Uda array antenna which consists of a feed radiator and some parasitic elements can provide directive emission in this regime [2,3]. Controlling antennas directivity facilitate the communication system with a useful nano-scale switch that may be employed for different purposes[4,5] including signal modulation [6].

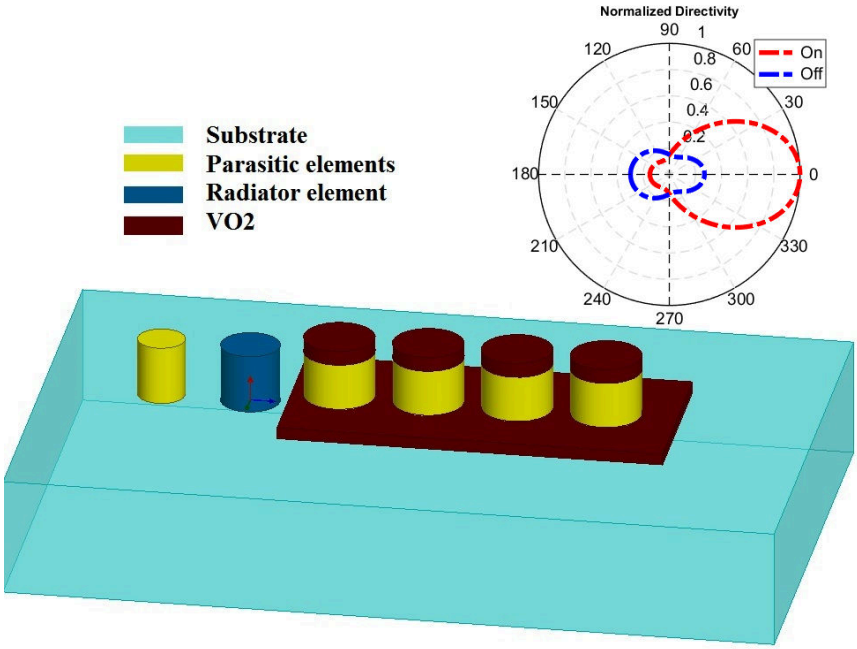

Figure **(1)** VO2-driven switchable-beam Yagi-Uda antenna array

This work proposes a switchable-beam directional antenna for micro/nano scale wireless communication. Phase transition of vanadium dioxide covering due to temperature variations shifts the resonance frequency [7] of parasitic elements in a Yagi-Uda array. Depending on the resonance frequency of the parasitic elements they may act as directors or reflectors; consequently, they can add to or reduce radiation in specific direction. As a

result, a control over radiation gain is achieved by manipulating phase transition of the phase change material.

REFERENCES

1. Alù A, Engheta N. "Wireless at the nanoscale: optical interconnects using matched nanoantennas," *Phy. Rev. Let*. Vol. 104, No. 21, 2010.
2. Kosako, T., Kadoya, Y. and Hofmann, H.F. "Directional control of light by a nano-optical Yagi–Uda antenna," *Nature Photonics*, Vol. 4, No. 5, pp.312-315, 2010.
3. Coenen, T., Vesseur, E.J.R., Polman, A. and Koenderink, A.F. "Directional emission from plasmonic Yagi–Uda antennas probed by angle-resolved cathodoluminescence spectroscopy," *Nano letters*, Vol. 11, No. 9, pp.3779-3784, 2011.
4. Kim, S.J., Lee, K., Lee, S.Y. and Lee, B. "Directional switching of surface plasmon polaritons by vanadium dioxide-gold hybrid antennas," *InSPIE OPTO*, pp. 975621-975621, 2016.
5. Chen, Y., Lodahl, P. and Koenderink, A.F. "Dynamically reconfigurable directionality of plasmon-based single photon sources," *Phys. Rev. B*,Vol. 82, No. 8, p.081402, 2010.
6. Zhu, Q., Yang, S., Yao, R. and Nie, Z. "Directional modulation based on 4-D antenna arrays," *Ant. & Prop. IEEE Trans*., Vol. 62, No. 2, pp.621-628, 2014.
7. Kats, M.A., Blanchard, R., Genevet, P., Yang, Z., Qazilbash, M.M., Basov, D.N., Ramanathan, S. and Capasso, F. "Thermal tuning of mid-infrared plasmonic antenna arrays using a phase change material," *Optics letters*, Vol. 38, No. 3, pp.368-370, 2013.